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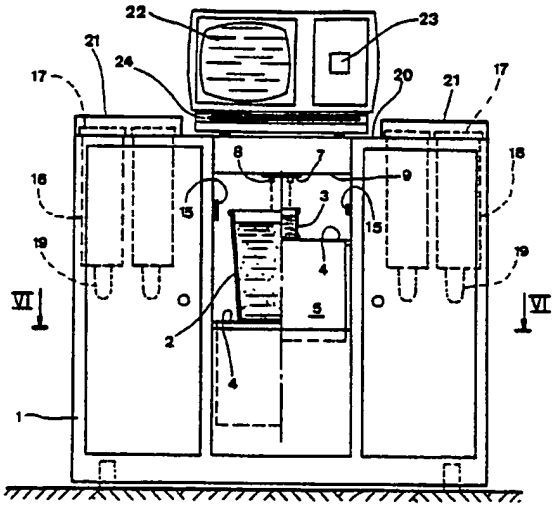
(54) Title: METHOD FOR THE BATCHING OF COLOURING AGENTS INTO PAINTS AND VARNISHES BY VOLUME, AND A MACHINE THEREFOR

(57) Abstract

The method disclosed is one wherein n pumps and n relative solenoid valves operated by a single microprocessor-controlled stepping motor dispense one or more of n colouring agents into a paint/varnish medium. The quantity dispensed is either a proper or improper fraction of an integer of 1/m of the volumetric unit of measure (fluid oz) and is defined p, a nominal value reflecting the number of half-steps indexed by the motor which is corrected proportionally by comparison of the effective and the nominal weight of a droplet downstream of the pump and upstream of the solenoid valve in order to produce an effective number of half-steps x. A similar correction is made to the number R of half steps which correspond to the delay occasioned by operation of the solenoid valve, comparing the effective and nominal weights of the droplet downstream of the valve; the speed of the motor is corrected to compensate for system resistances. The machine comprises a single motor (26) operating the n pumps (25) which dispense colouring agent from n relative containers (16) by way of n nozzles (8) located above a vertically-mobile platform (4) on which the container (2/3) with the medium is placed, its position controlled by a photocell (15). All of these components are housed in a cabinet comprising a basic framework (1) the top surface of which accommodates a computer (22, 23, 24) with circuit boards controlling operation of the machine according to the method as disclosed; data is displayed by video and documented by a printer.



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M thod for the batching of colouring agents into paints and varnish s by volume, and a machine th r for.

The invention relates to a m thod for the batching of colouring agents into paints and varnishes by volume, and to a machine therefor: that is, a new method that will permit of colouring a medium in a wholly new fashion, utilizing a new type of machine which the application also seeks to protect; such paints and varnishes are of a universal type, being applicable on wood, metalwork and masonry.

The prior art embraces machines of the following types:

- Manual, semi-automatic or fully automatic plunger types featuring a set of vertically-disposed dispensers with respective cylinders, equal in number to the colours to be batched into the medium, each containing and supplying a single colour. The accuracy of such machines, particularly doubtful in the case of manual operation by reason of the human factor, improves with automation; nonetheless, the hydraulic circuits used to control reciprocating motion of the plungers involve high cost and occasion drawbacks, and there is always considerable down-time due to the return stroke of the plunger which refills the dispenser cylinder with the colouring agent. Also, such machines are characterised by low efficiency, especially in the conversion of electrical power to mechanical power.

- Positive displacement pump types, featuring pumps and solenoid valves with relative d.c. motors and couplers equal in number to the single colours to be batched into the medium, which recirculate excess colour via a closed circuit. Whilst being a better class of machine than that aforedescribed, this type is also made uneconomical by the need for a large number of d.c. motors, all of which require setting, amongst other things, and for costly systems and attendant servicing.

When automated, machines of the prior art types also become noticeably larg and cumb rsome. Lik wise to be taken into consideration is the fact that a need for sample cards which must satisfy ever-increasing r quirements for a greater number of shades in each colour manufactured,

accentuat s th problem of improving batching accuracy, which in such traditional machines tends to be of the order of 5 to 20%. Such figures in no way permit of obtaining all the shades currently demanded, since the inaccuracy in batching is such that mixes do not correspond to the actual shade envisaged, and the shades themselves become confused one with another.

The prior art thus outlined leaves room for considerable improvement in the area of obtaining maximum possible accuracy in batching of single colours, and by definition, a maximum possible extension of the number of shades whilst ensuring that one remains perfectly distinguishable from the next; thus one can increase the range of samples without the shades most alike becoming confused one with another.

From the foregoing, one may discern the need for a solution to the problem of developing a new method which will permit of limiting error in the batching of colouring agents to a bare minimum, say, $\pm 1\%$, or even less, constantly, and regardless of viscosity, and of applying such a method in practice by way of a simple, compact and cost-effective machine.

The above problem can be resolved by adoption of the method disclosed herein, a method new both in theory and in practice, wherein n pumps, serving n solenoid valves that dispense one or more of the n colouring agents into the medium, are all operated by a single electric motor, and more precisely a microprocessorcontrolled stepping motor, in such a way as to dispense the colouring agents in proportion equivalent to a proper or improper fraction, or to the integer (that is, less or greater than, or equal to 1) of a given droplet, equal to 1/m of the volumetric unit of measure (fluid ounce) and definable as a quantity the admixture of which marks the distinction between single shades. The droplet in question is defined p, a nominal value reflecting the number of half-steps that must be completed by the rotor of the electic motor, according to pump flow rate per revolution of the motor itself. The droplet delivered by the pump is weighed upstream of the relativ solenoid valve, and the effective weight thus registered is compared with a nominal weight,

computed by multiplying the specific weight of the colouring agent by the volume obtainable from the pump with p half-steps of the motor, thereby determining the correct number of half-steps x required to produce the droplet by way of a linear equation.

To offset the time-lapse required for operation of each relative solenoid valve in opening and closing (the former longer than the latter), a nominal valve operation delay R is computed, in half-steps, from the difference between the two time-lapses and the number of pulses that the motor receives per unit of time. The droplet is then re-weighed downstream of the solenoid valve, whereupon effective and nominal weights are compared once again utilizing the same procedure as for the comparison upstream so as to permit of converting the nominal number R of half-steps into an effective number y, thereby arriving at the preset level of batching accuracy.

The machine utilized for carrying such a method into practice consists of a compact cabinet provided with two side compartments, the top of each of which has openings ranged along either side for the insertion of containers and relative stirrers, n/2 in number, holding the colouring agents.

A central enclosure between the two side compartments is provided with a platform which can be raised and lowered on guides by an actuator, and upon which the container holding the medium is positioned, controlled by a photocell, to receive the colouring agents from a circular bank of nozzles, n in number, each of which supplied by a solenoid valve downstream of the relative pump.

The stepping motor is located at bottom centre and operates the pumps, likewise n in number, by way of transmission links and timing belt-and-pulley drives at either side.

A computer with video, keypad and printer sits on top of the cabinet. The main circuit board of the computer interconnects six additional boards: CPU; function-select, photocell and sensor input control: six sensors detect proximity of six different sizes of container, singly, in relation to the vertically-mobile platform and to its position; video, keypad

and printer; outputs, n in number, to the solenoid valves; system control functions (n stirrers, platform raise/lower actuator, motor power supply and rotor st p count); and a permanent memory.

The method, and an embodiment of the machine, will now be described in detail by way of example, with reference to the six accompanying sheets of drawings in which:

fig 1 is the front elevation of a machine according to the invention, designed to batch 16 colouring agents, the left half of the drawing illustrating the position occupied by the largest size container of the medium during admixture of the colouring agents, the right half illustrating the position occupied by the smallest size of container;

fig 2 is a plan of the machine in fig 1, seen partly in cutaway;

fig 3 is the vertical cross section through III-III in fig 2, seen in enlarged scale;

fig 4 is a vertical section through IV-IV in fig 2, the longitudinal axis of the machine, seen in enlarged scale;

fig 5 is a vertical and longitudinal section through V-V in fig 2, drawn in enlarged scale better to show the transmission links between the one motor and the 16 pumps;

fig 6 is the horizontal cross section through VI-VI in fig 1, seen in enlarged scale;

figs 7 and 8 show the computer video and key layouts, respectively;

fig 9 is a block diagram of the microprocessor which illustrates the arrangement of the circuit boards in the monitor enclosure.

With reference to the drawings, 1 denotes the framework of the cabinet housing the machine; 2 and 3 are containers of the medium, of the maximum and minimum permissible size, respectively, either of which is positioned on the platform 4 of an L-shaped bearer 5 that is slidable through a vertical path and moved thus by an electrically-operated linear actuator 6 (figs 3 and 4) hinged at its lower end to the bottom of the framework 1. 7 denotes a disc to which sixteen batching nozzles 8 for the colouring agents are made fast, the disc in turn being made fast to a shelf 9 that accommodates

sixte n relative solenoid valves 10, and in effect is the top surface of an open-fronted box structure with v rtical walls 11, 12 and 13 which rests on the bottom shelf 14 of the framework 1. 15 denotes a photocell which detects either the lack of any container on the platform 4, or the presence of a container of incorrect shape and/or size. The colouring agents are stocked in containers 16 (of which there are sixteen in the embodiment shown) each with a lid 17 and an internal stirrer 18 turned by a respective electric motor 19. Each container is positioned vertically in a respective opening in the top surface 20 of the framework 1, resting on the lip of the opening itself; the top surface 20 has a cover 21 at each side, hinged at rear to the framework 1 so as to permit of gaining access to the two sets of eight containers. 22 is the computer video, 23 the printer, and 24 the keypad. The machine comprises positive displacement pumps 25 (one for each container 16) the flow rate of which can be varied by variation in the speed of rotation of a single electric motor 26, a stepping motor the rotor of which is designed to locate 400 distinct angular positions within one revolution; 27 denotes the double-extending shaft of the motor 26. Each end of the motor shaft 27 connects by way of a respective coupling 28 with a relative input shaft 29 journalled to a base 30 located inside the framework 1. A wide-face timing pulley 31 keyed to each input shaft 29 transmits drive by way of a relative timing belt 32 to two identical pulleys 33 keyed to the common drive shafts 34 of four pumps 25 mounted in pairs to the base 30. Rotation imparted at either side of the machine to these pulleys 33 is relayed in turn by way of further belts 35 to the pulleys 36 of the remaining two pairs of pumps 25; thus one has two drive systems, one either side of the machine, each one driving eight pumps.

The bottom of each container 16 connects with the intake of a relative pump 25 below by way of a tube 37; a further tube 38 connects the pressure outlet of each pump 25 with a respective solenoid valve 10, and a recycle tube 39 returns the excess colouring agent from the valve to the bottom of the respective

container 16; an extension 40 of the recycle tube 39 is located inside th container 16. 41 denotes a double-extending shaft (fig 4) issuing from ither side of the L-shaped bearer 5 at its rear end and having rollers 42 which locate in vertical guides 43 integral with the walls 11 and 12 of the box-structure; this same shaft serves as the trigger element for the container size proximity sensors. With reference to the keypad 24 (fig 8), 44 denotes the keys utilized for entering quantities of medium to which colouring agents must be admixed; 45 ... 53 are keys governing the following functions:

key 45 - check on colouring agent batch data at the start of each work shift;

key 46 - check on the level of colouring agent in each container;

key 47 - display remarks;

key 48 - print out batch formulae (printer23);

key 49 - dispense selected colouring agent from the nozzles 8;

key 50 - memorize batch formulae;

key 51 - access tables with settings of the viscosity of colouring agents, delay times for operation of solenoid valves 10, and speed of motor 26;

key 52 - select from batch formulae already on file;

key 53 - develop new batch formulae, which can also be memorized, by manual operation of nozzles. All the above functions are displayed on the video. 54 denotes a slot in which to insert cassettes or cards with formulae other than those currently on file, and 55 denotes an array of indicators, one to each colouring agent. With reference to the block diagram of fig 9, AL denotes power supply to the main circuit board SM, from which further circuit board connections are taken:

CPU - central processing unit interface;

INP - inputs relative to the selection of machine functions, the photocell detecting position of the paint/varnish container 2 or 3, and the six sensors which detect proximity of the six size of container and relative position of the platform 4;

VID - video, keypad and printer interface;

OUTE - outputs controlling the sixteen solenoid valves 10;

OUTV - outputs controlling machine sistems: sixteen stirrers (8 left, 8 right), ascent and descent of the bearer 5, power

supply to the motor 26 and rotor step count;
MP -permanent memory interface.
Op ration is as follows.
Having selected the number of the shade desired from the sample card the operator depresses key 52 and enters the number via the video whereupon, using one or the keys denoted 44, the quantity of medium to be coloured is selected in order to determine the size of container 2 or 3. With the container in position on the platform 4, the operator depresses key 49 to commence batching of the colouring agent or agents from one or more nozzles 8. Mixed colouring can be produced by utilizing key 53. The method is carried into effect utilizing three tables.
The table of viscosity settings for the selected colouring agents, accessed with key 51, consists of sixteen nominal values, one for each agent, which can be obtained singly as follows: assuming a positive displacement pump 25 with flow rate Q = 6 l/min at 1400min^{-1} and a motor 26 capable of 400 half-steps per revolution, flow rate Q1 of the colouring agent per revolution is determined at Q1 = 6000/1400 = 4.2857cm^3/rev, and from this figure one can calculate flow rate Q2 per half-step of the motor, thus: Q2 = 4.2857/400 = 1.071 x 10^{-2}cm^3/half-step. With reference to the European metric fluid ounce, equivalent to the US fluid ounce of 29.5735 cm^3 plus 5.67%, and given that 1/96 of the metric fluid ounce is 0.3255 cm^3, it can be calculated that the number of half-steps required to batch 1/96 of the fluid ounce in question is 0.3255/0.01071 = 30.38. A person skilled in the art will be aware that 1/96 of a fluid ounce of colouring agent is the fraction which, conventionally, marks the distinction between one colour shade and the next. Using the machine according to the invention it becomes possible even to halve this fraction, thereby doubling the range of shades available.
The table of solenoid valve operation delay times is also accessed with key 51, and consists likewise of sixteen nominal values, one to each colouring agent, obtained as follows: given the pulse frequency of which the motor 26 is in receipt, say 1216 Hz, at a speed of 182.4 min^{-1}, and given the time-

lapses produced by the op ning movement of the valve (15×10^{-3}sec) and its closing movement (8×10^{-3}sec), the difference between these two is 7×10^{-3}sec, so that the delay produced by operation of the valve, expressed in half-steps, is $1216/1000 \times 7 = 8.512$. For example, if one wished to batch a quantity of colouring agent equal to 50/96 of a European metric fluid ounce, the nominal number of half-steps needed to dispense 1/96 of a metric fluid ounce having been established at 30.38, then multiplication will produce the figure of 1519 half-steps, to which must be added the delay of 8.512 half-steps, thereby producing an effective overall time-lapse of R = 1527.512 half-steps. The motor speed table, likewise accessed by key 51 and utilizable in the same way, consists of a delay the entity of which is set at, say, 1×10^{-5}sec per half-step. Such a delay is utilized to an extent defined by effective system resistance from the pump assemblies, and relative pressures and load losses, which will generally vary from pump to pump and from one drive system to another; setting of the motor speed is controlled directly by the computer, as is utilization of the setting tables themselves.

The system is set up for operation on the basis of table data. With the viscosity table accessed, the operator enters the nominal number of half-steps the motor 26 must turn in order to dispense 1/96 of a European metric fluid ounce, say, 30.38 half-steps, then checks the effective weight of the droplet produced downstream of the pump 25 and upstream of the relative solenoid valve 10, comparing this with the nominal weight, which is the product of the specific weight given by the table of colouring agents and the volume delivered by the pump during the number of half-steps in question. Where the effective weight and nominal weight do not coincide, the nominal number of half-steps (30.38 in the example) must be altered to compensate for the greater or lesser weight delivered by the pump, by an amount calculated thus: nominal weight: half-steps = effective weight : R, where R is the effective number of half-steps which replaces the nominal 30.38, if necessary.

As far as regards the table of solenoid valve delay values, in the instance described above, where 50/96 of a metric fluid ounce must be dispensed with a delay of 8.512 half-steps (equivalent to 7msec), the valve operation delay is checked by making a further comparison between nominal and effective weight of the droplet downstream of the valve, adopting the same criteria as that described for the viscosity setting following comparison upstream of the valve and downstream of the pump, and correcting the value accordingly. It will be appreciated that the results produced by such comparison, expressed in terms of weight, can be converted into volumetric data.

In practical application, the option exists of embodying components other than as illustrated and described -viz, the position of keys 44 and 45 ... 53 on the pad 25 is by no means binding, and the pumps 25 and solenoid valves 10 might be any of several suitable types. Likewise, the unit of measure used for reference purposes could be other than the fluid ounce, and the numbers n and m, 16 and 96 respectively could be greater or less.

CLAIMS

1. A method for the batching of colouring agents into paints and varnishes by volume, and a machine therefor comprising n pumps with n relative solenoid valves and recycle circuits which dispense one or more colouring agents from containers, each provided with a relative stirrer, into the medium, delivering a quantity based on proper or improper fractions or integers of a droplet measuring 1/m of a fluid ounce where, conventionally, n = 16 and m = 96, values regarded hitherto, in the art field as accepted limits, characterised, in that the n pumps, serving n solenoid valves that dispense one or more of the n colouring agents into the paint or varnish, are all operated by a single electric motor, and more precisely a microprocessorcontrolled stepping motor, in such a way that each dispenses a droplet of colouring agent measuring p, a nominal value reflecting the number of half-steps that must be completed by the rotor of the electric motor, according to pump flow rate per revolution of the motor itself, and which is corrected proportionally utilizing data entered in a table of viscosity settings run by the microprocessor, by comparison of the effective weight of the droplet delivered by the pump, upstream of the relative solenoid valve, with its nominal weight, thereby determining the correct number of half-steps x effectively required; in that a table of solenoid valve delay settings, likewise run by the microprocessor, permits of correcting a nominal valve operation delay time-lapse R computed in half-steps from the difference between the opening and closing movement time-lapses and the number of pulses that the motor receives per unit of time, by comparison of the effective weight of the droplet downstream of the solenoid valve with its nominal weight, so as to convert the nominal value R proportionally into a corrected value y reflecting the effective valve operation delay; and in that a table which permits of setting motor speed, controlled directly by the microprocessor, provides for a delay per half-step of the rotor in order to compensate for resistances to its movement from the system.

2. A machine according to the method of claim 1, the essential

features of which are: a cabinet having a framework (1) which creates two compartments, located uppermost at either sid and accommodating contain rs (16) for the colouring agents, and a central enclosure between the two side compartments provided at front with a platform (4), raised and lowered by an actuator (6) hinged to the base of the framework, upon which a container (2, 3) holding the medium is positioned, controlled by a photocell (15), beneath a circular bank of nozzles (8) supplied by way of the solenoid valves (10) from relative pumps (25); one stepping motor (26), located centrally on the bottom shelf of the framework in such a way as to turn two input shafts (29), one at each side, which drive relative trains of timing pulleys (31, 33, 36) and belts (32, 35) thereby rotating shafts (34) that are common to pairs of pumps arranged in two sets; and a computer comprising video (22), printer (23) and keypad (24), positioned on top of the cabinet.

3. Machine as in claim 2, wherein the keypad (24) is provided, at least, with:

- keys (44) for entering batch quantities of medium and admixture of colouring agents;
- a key (45) giving a check on colouring agent batch data at the start of each work shift;
- a key (46) giving a check on the level of colouring agent in each container;
- a key (47) producing a display of remarks;
- a key (48) to produce print out of batch formulae via the printer (23);
- a key (49) instructing egress of selected colouring agents from the nozzles 8;
- a key (50) for memorization of batch formulae;
- a key (51) for accessing tables with settings of the viscosity of colouring agents, delay times for operation of the solenoid valves (10), and speed of the motor (26);
- a key (52) enabling selection from batch formulae already on file;
- a key (53) permitting the development of new batch formulae, which can also be memorized, by manual operation of nozzles.

4. Machine as in claims 2 and 3, wherein the computer is

equipp d at least with circuit boards arranged thus:
- a main circuit board (SM),
- a board (AL) supplying power to the main circuit board;
- a central processing unit interface board (CPU);
- an input board (INP) controlling machine functions, the photocell (15) detecting position of the paint/varnish container (2, 3), and the sensors detecting proximity of such containers according to size;
- a video (22) printer (23) and keypad (24) interface board (VID);
- an output board (OUTE) controlling operation of the solenoid valves (10);
- an output board (OUTV) controlling operation of the machine systems: stirrers (18), ascent and descent of the platform (4), power supply to the motor (26) and rotor step count;
- a permanent memory interface (MP).

Fig.1

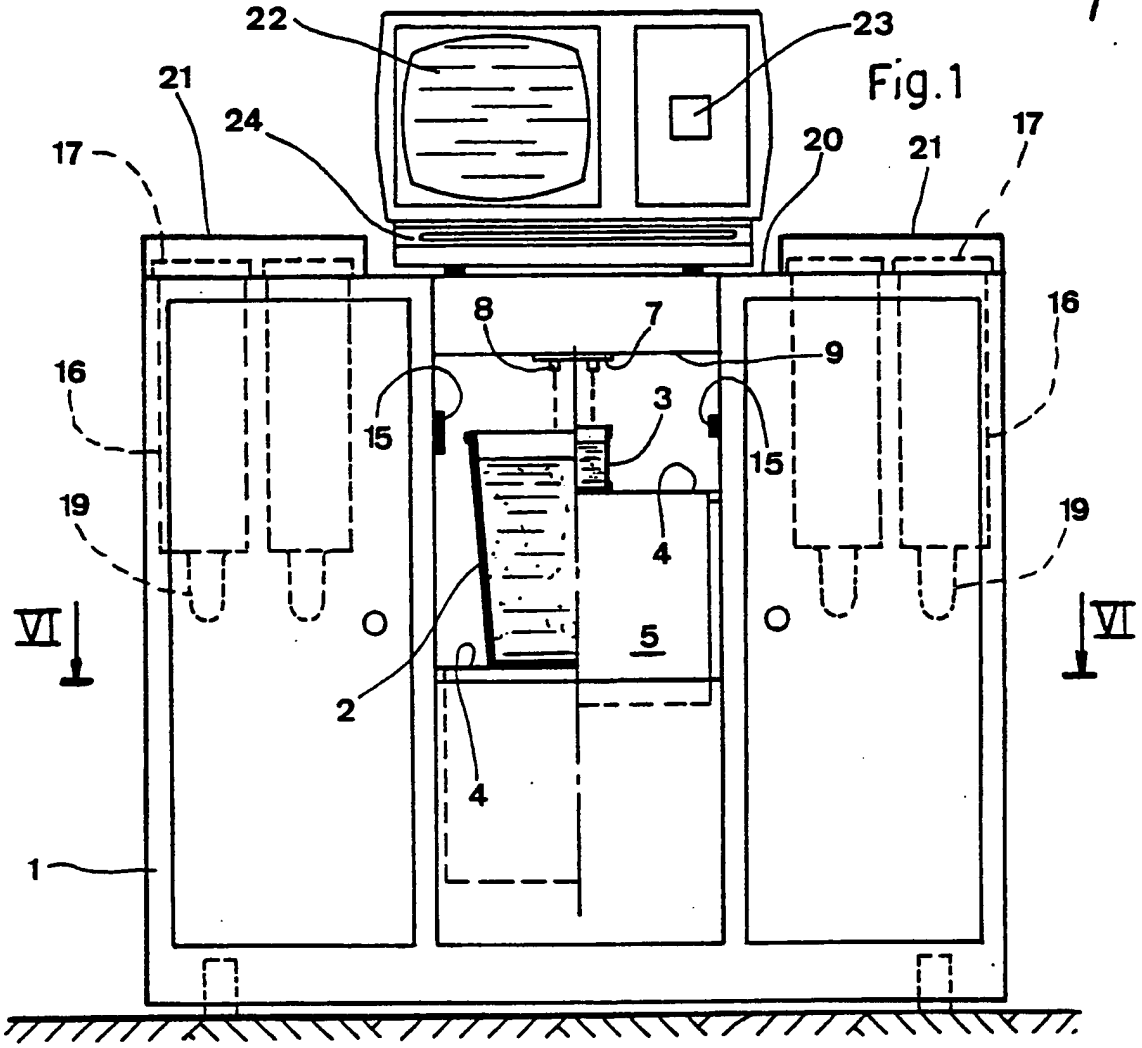
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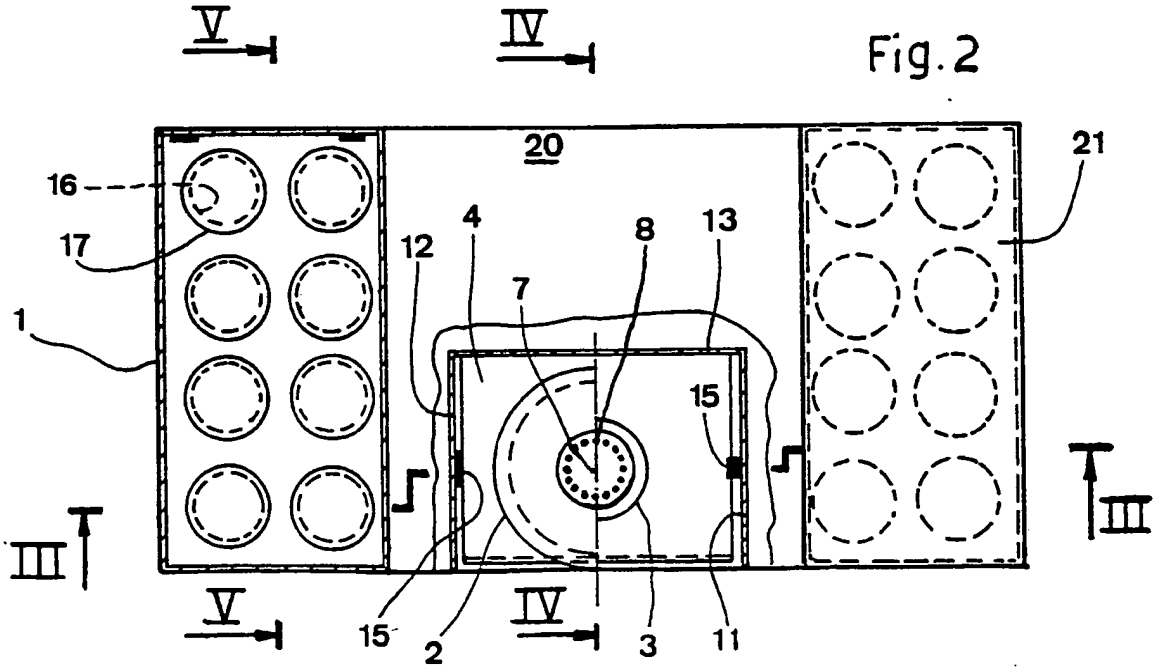
Fig.2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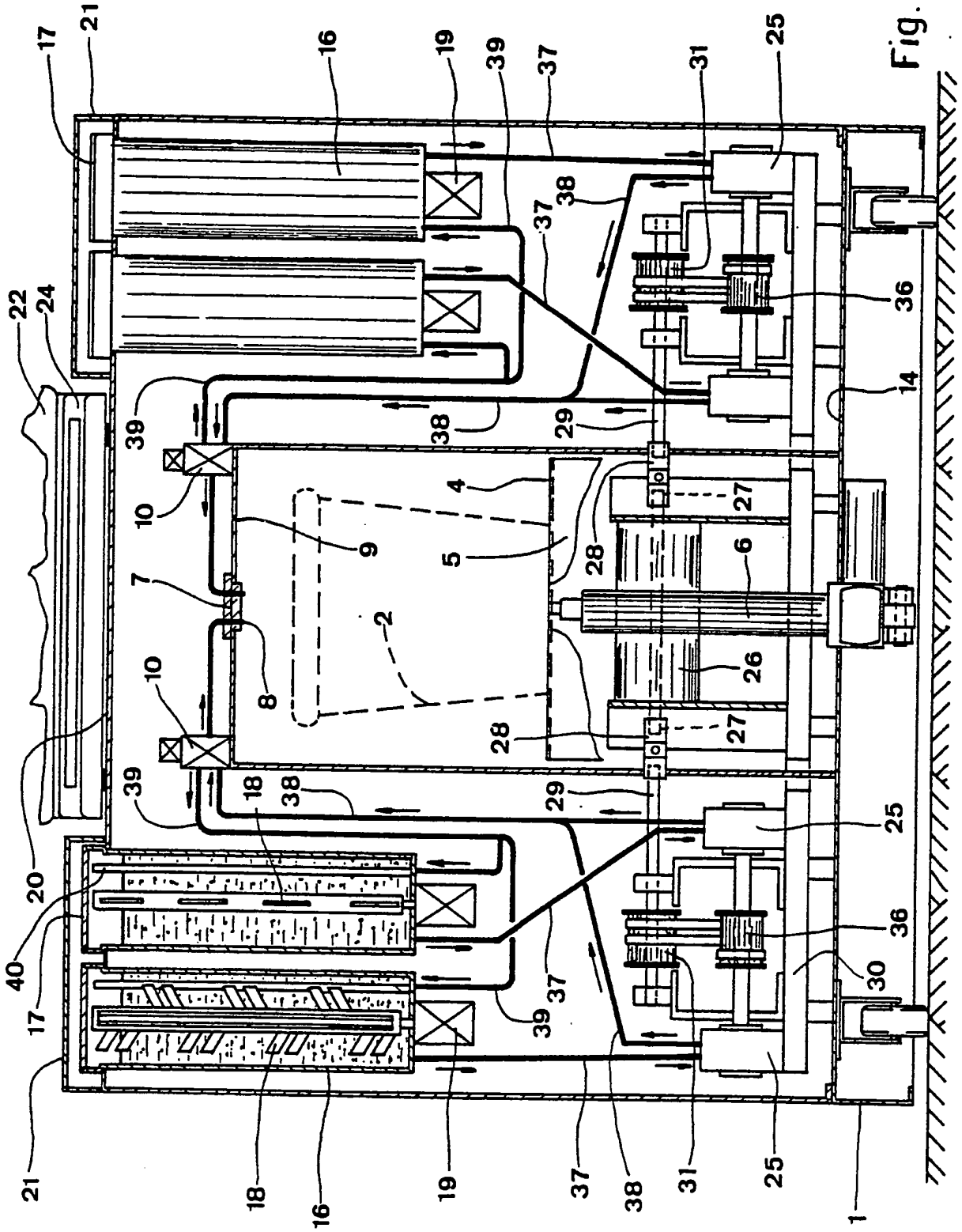
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Fig. 3

Fig.5

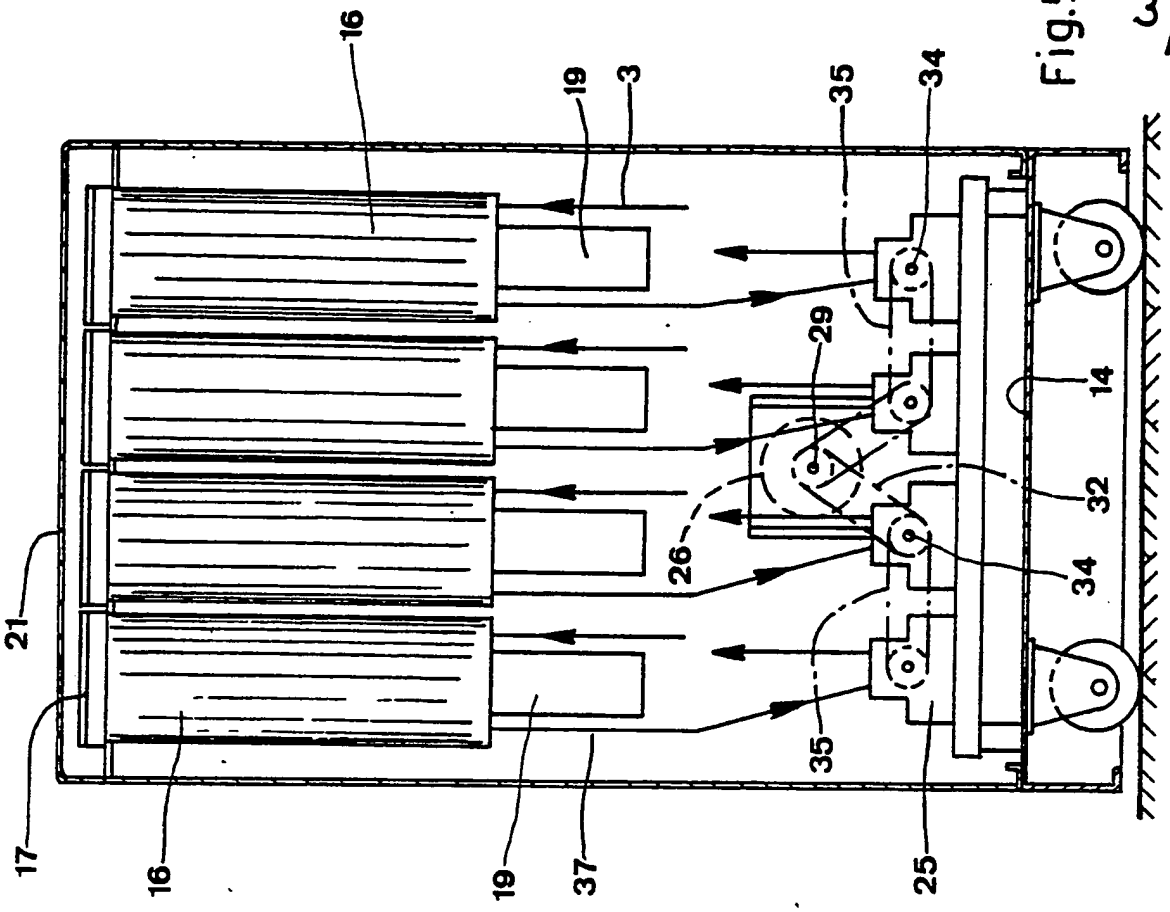
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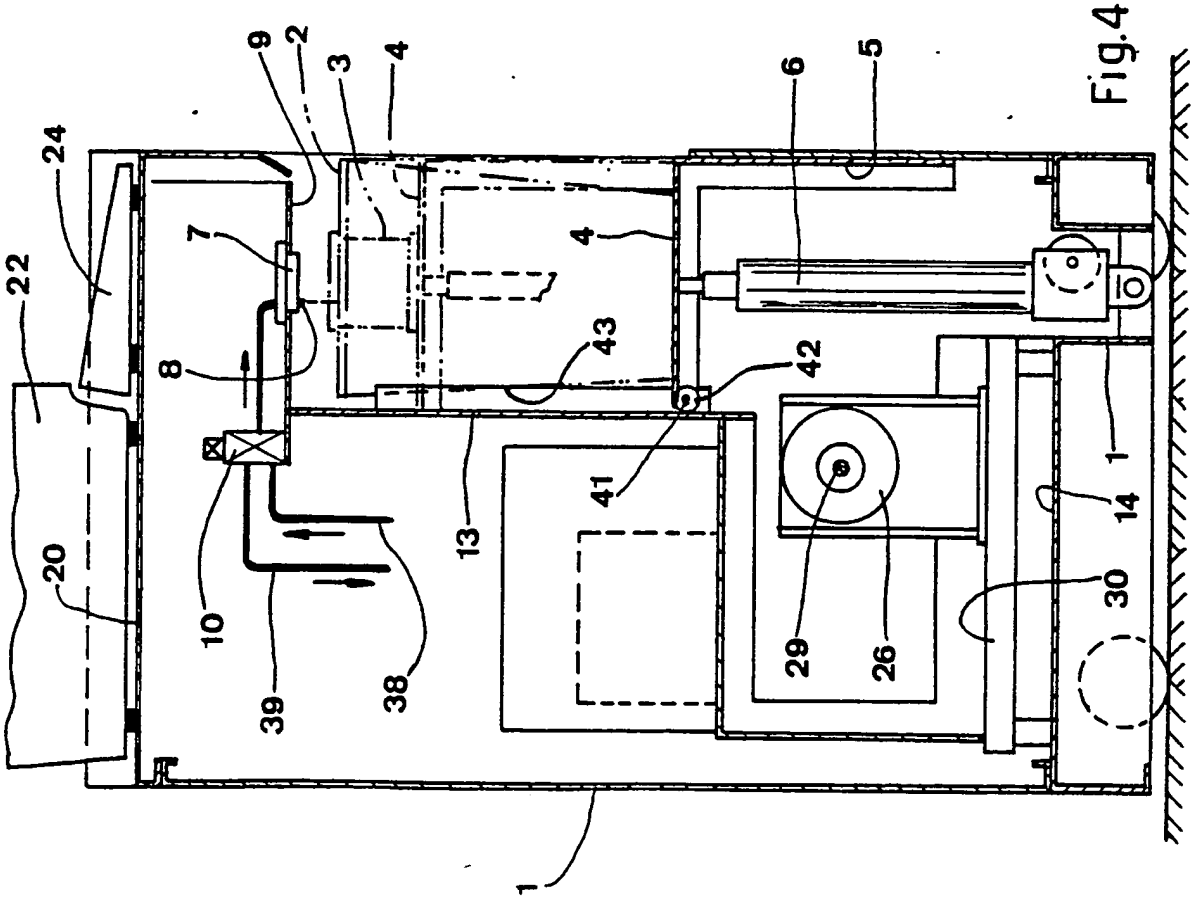
Fig.4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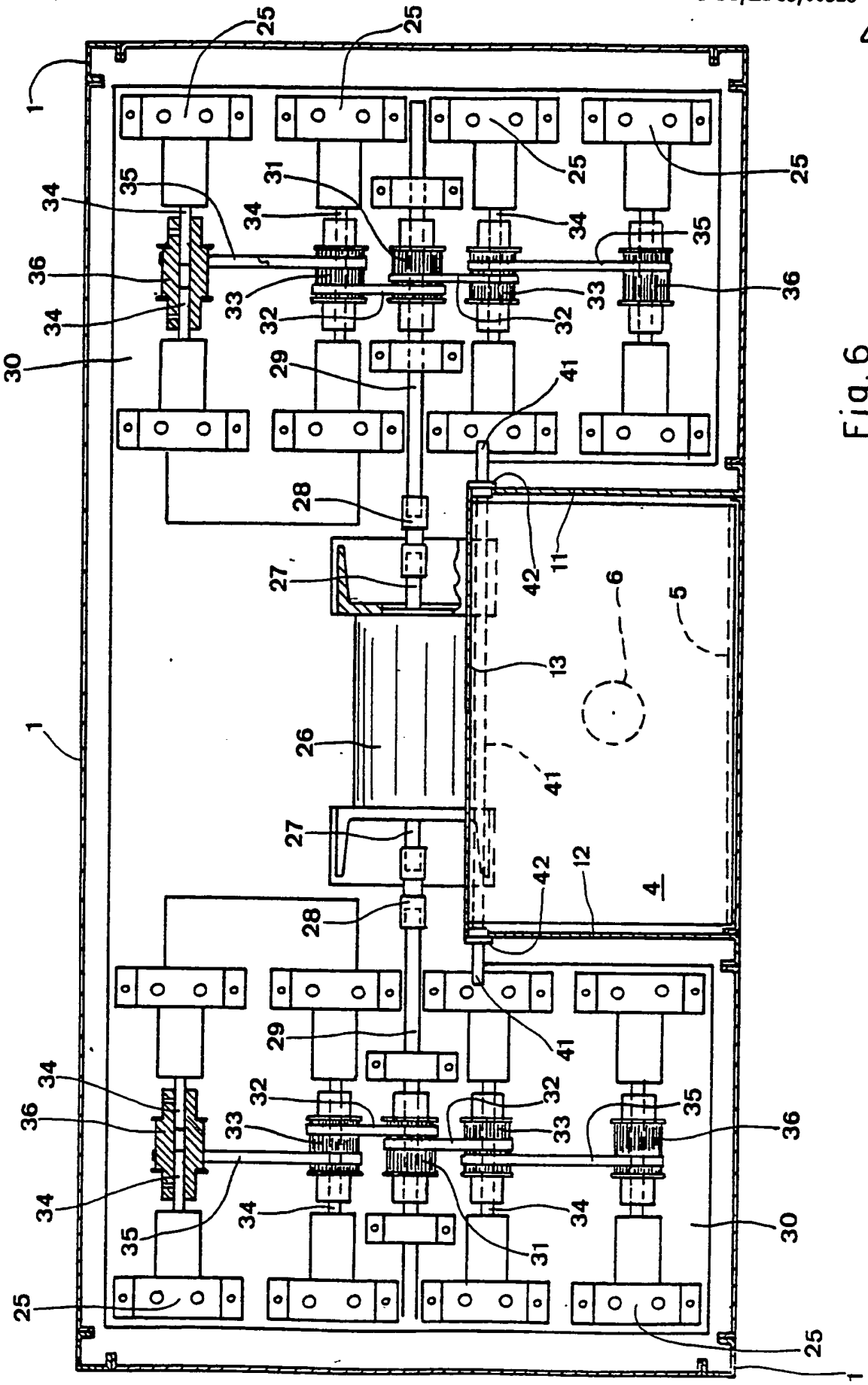


Fig. 6

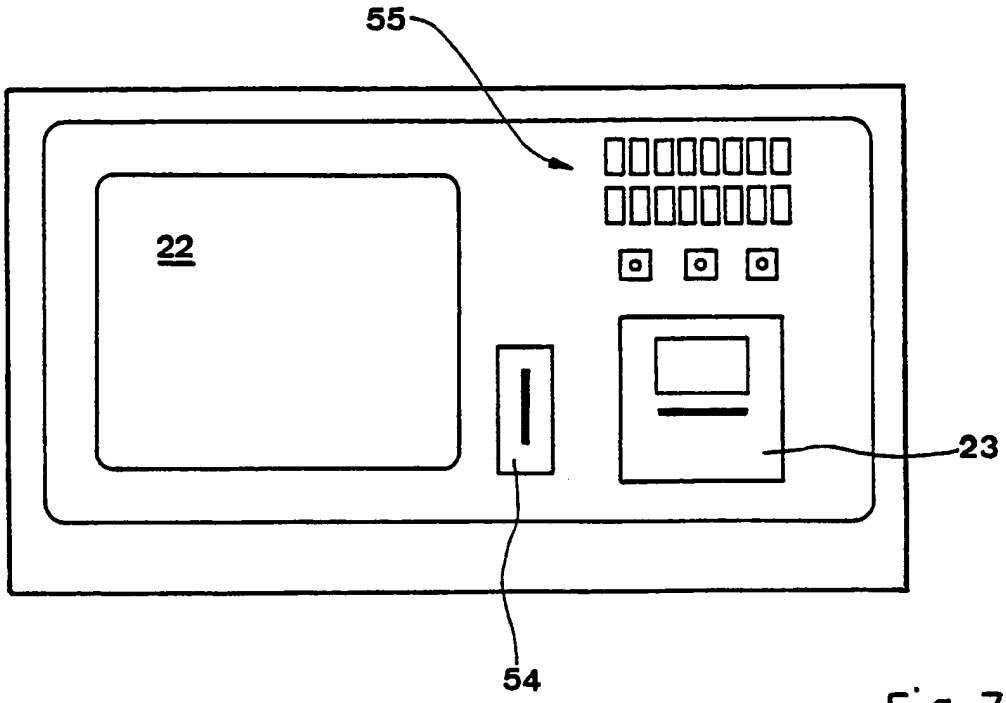
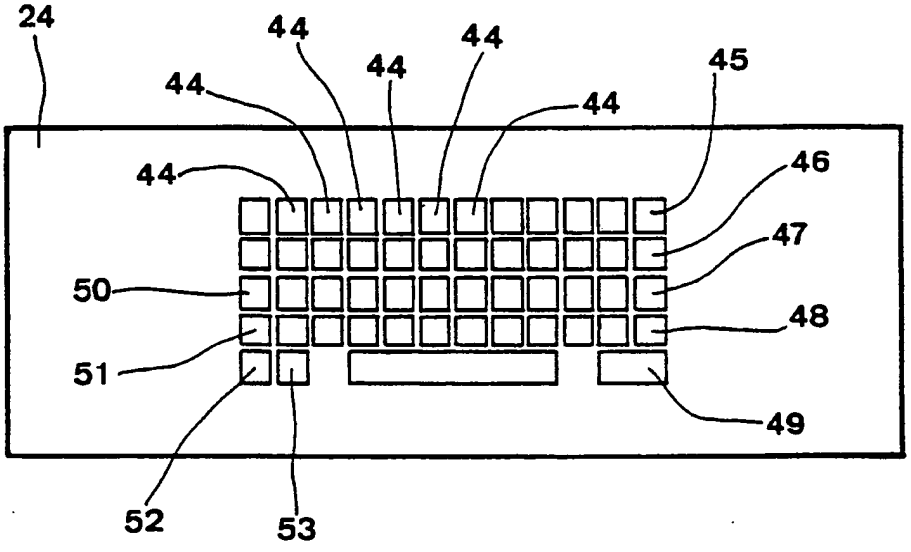


Fig. 7

Fig.8



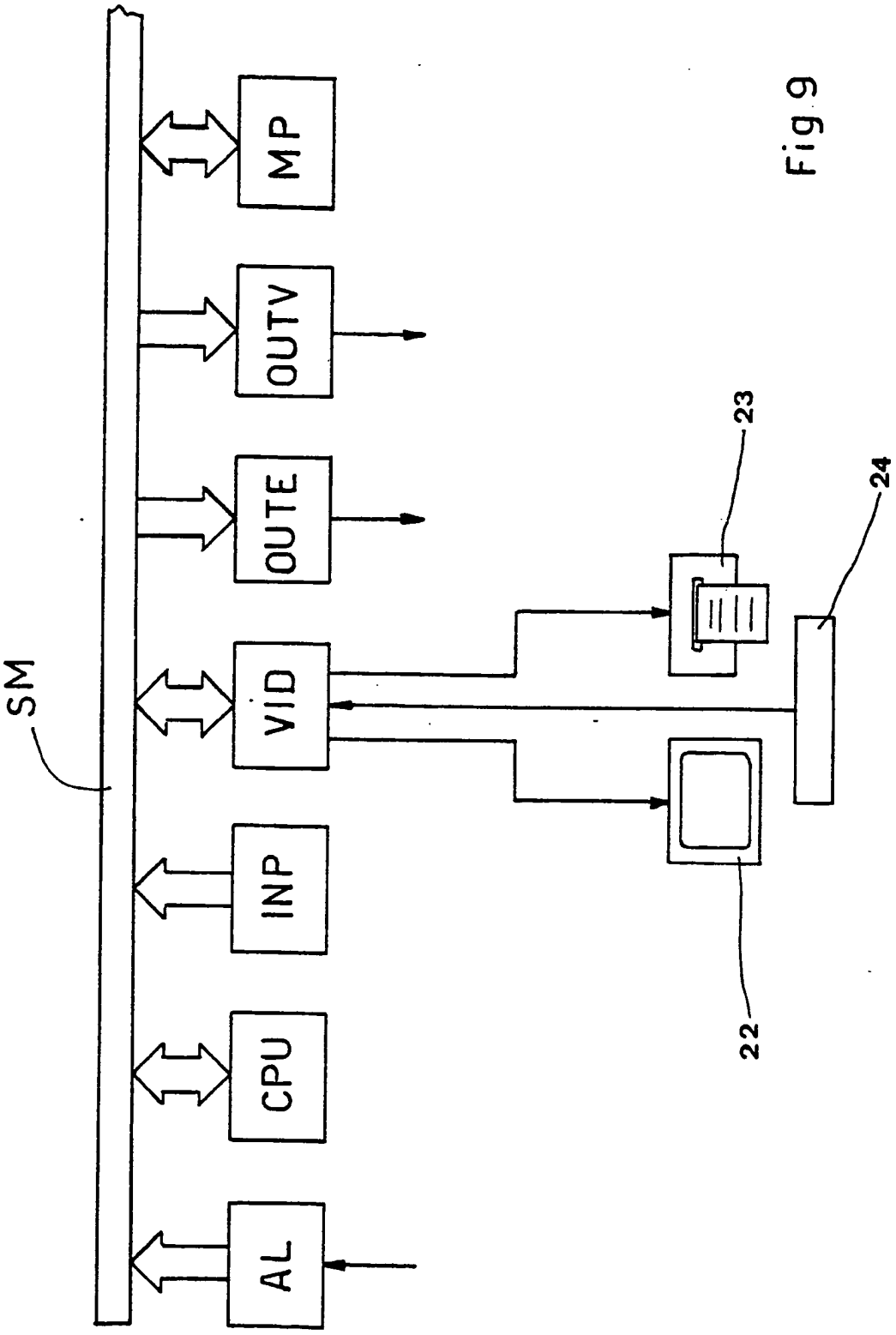


Fig 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 85/00528

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 44 D 3/00; B 01 F 15/04

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 44 D 3/00 B 01 F 15/04 G 05 D 11/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 3670785 (F. HEISS et al.) 20 June 1972, see column 5, lines 46-75; column 6, lines 1-11,47-76; figure 4 --	1
A	US, A, 4403866 (A. FALCOFF et al.) 13 September 1983, see column 3, lines 49-65; column 5, lines 23-36 --	1
A	DE, A, 2529101 (K. BÖSCH) 3 February 1977, see page 4; page 5, lines 1-15; figures 1-2 --	1
A	US, A, 2848019 (M. CORBIN et al.) 19 August 1958, see column 1, lines 30-58; column 3, lines 34-47; column 4, lines 3-26, 68-76; figures 1,3 --	1
A	US, A, 4314653 (G. SINDONI) 9 February 1982, see column 2, lines 42-65 --	1
A	Feinwerktechnik & Messtechnik, volume 91, nr. 3, May 1983 W. Zylka:"Dosierpumpenantrieb mit Schrittmotor", pages 111-112, see paragraphs 2,3	1

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20th December 1985	23 JAN. 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

III. DOCUMENTS CONSIDERED T BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	Aufbereitungstechnik, volume 23, nr. 1, January 1982, Wiesbaden, (DE) H. Weinberg:"Wäge- und Dosiersysteme für diskontinuierliche Verfahren", pages 1-7, see page 5, paragraph 4.2; figure 7 --	1,3
A	DE, A, 3201221 (W. RIBIC) 28 July 1983, see page 9, lines 6-22; page 10, lines 1-11	1,3

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/EP 85/00528 (SA 10880)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 16/01/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3670785	20/06/72	None	
US-A- 4403866	13/09/83	EP-A- 0094218	16/11/83
		JP-A- 58204066	28/11/83
DE-A- 2529101	03/02/77	None	
US-A- 2848019		None	
US-A- 4314653	09/02/82	None	
DE-A- 3201221	28/07/83	None	